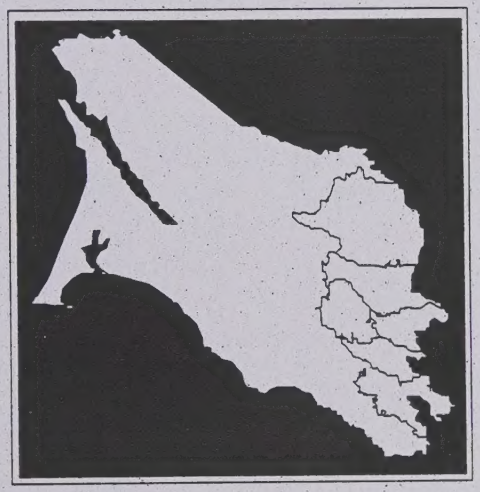
The Marin Countywide Plan

Transportation Element Technical Report #3
Transportation Existing Conditions



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EXECUTIVE SUMMARY

The Existing Conditions report provides base line information for the update of the Countywide Plan. Projected future conditions will be compared and evaluated against the information contained in this report. The analysis begins with an evaluation of transportation policies in the Countywide Plan adopted in 1982 and continues with a description of traffic conditions, transit service, airport facilities, trends which contributed to traffic congestion during the 1980s and a list of transportation system improvements undertaken during the 1980s.

The Transportation Element of the 1982 Countywide Plan begins with the acknowledgement that the proposed system of 1980 was "scaled back" compared to that contained in the 1973 plan. Even with a less ambitious plan, the document stated: "New sources of funding must be found; if they are not, serious congestion problems will occur in the next decade." The policies were based on the assumption that new sources would be found. New sources of funding were not found and congestion occurred as predicted.

At the time the 1982 plan was written the country was slowly recovering from an energy crisis resulting from high gasoline prices and uncertain supply. Transportation planning was heavily influenced by energy conservation and efficiency concerns. Numerous policies focused on alternatives to the automobile such as transit, carpooling, bicycles, and walking. Key to providing these alternatives was funding. Expansion of the transit system was predicated upon voters passing a one-half cent sales tax in 1980. The voters did not pass the tax. Implementation of carpool programs would also have required funding which did not materialize. Relatively high rates of inflation in the early 1980s reduced the purchasing power of available funds and a general antipathy towards increasing taxes ensured that increased funding would not be available to accommodate increased demand.

As the decade progressed, the energy crisis disappeared. Gasoline prices fell relative to other prices and supplies became plentiful. The economy entered a period of prosperity, producing a record number of new jobs nationwide. Commuting patterns shifted as a result of suburban job growth. With gasoline prices remaining low, people chose to drive alone, rather than take transit or carpool. The result was a large number of vehicles on the roads, more vehicles than some roads could accommodate during the morning and evening peak commute hours. Traffic congestion worsened because sufficient funding was not available to increase the capacity of the system.

Traffic congestion became most severe on Highway 101 and on some important arterials. During the morning peak hour in the southbound direction, backups occurred at Ignacio, south of Novato, and Puerto Suello Hill near the Civic Center. During the

evening peak hour in the northbound direction, backups occurred near Larkspur Landing and Pacheco Hill between Marinwood and Ignacio. Sir Francis Drake suffered congestion at the intersections of Wolfe Grade, La Cuesta, Eliseo Drive and Larkspur Landing Road. Weekend traffic conditions continued to deteriorate on State Route 1 through Tamalpais Valley and along Sir Francis Drake Boulevard between Fairfax and the San Geronimo Valley.

Transit ridership decreased between 1980 and 1990 on commute and basic service routes into San Francisco. Carpooling also declined. The number of people driving alone increased. After a decline in the early 1980s, ridership on basic service routes, those operating only within Marin, increased gradually. This was in part due to restored service provided by a $600,000 annual infusion from the Marin County Transit District. Ridership on Local Service routes within Marin decreased between 1980 and 1990.

In an effort to generate greater use of the carpool lanes, the County persuaded the California Department of Transportation to reduce the vehicle occupancy requirement for using the carpool lanes from three persons to two. After a study, Caltrans concluded that many two person carpools shifted into the carpool lanes and some three person carpools shrank to two persons. Caltrans also concluded that no new carpools formed.

The factors that caused traffic congestion were: 1) a large increase in the number of jobs in Marin; 2) increased reliance on the automobile as a mode of travel; 3) greater geographic dispersion of jobs and housing; and 4) an increase in the number and percentage of people working. The 3.4% increase in population of Marin County from 1980 to 1990 has had a negligible influence on traffic congestion.

The funds allocated to transportation system improvements during the 1980s were modest compared to the increased demand placed upon the system. Projects were implemented to relieve congestion at several locations and smooth the flow of traffic. The major bottlenecks on Highway 101 remain. Funding for additional carpool lanes and auxiliary lanes has been allocated as available from state and/or federal sources. A proposal to increase the local sales tax by one cent to complete the carpool lanes, build a light rail train, and increase transit service was defeated by the voters in 1990.

I. PURPOSE

The purpose of the Existing Conditions report is to provide the current information about the transportation system in Marin County. Projections of travel demand will be compared to existing conditions in order to determine what impacts would result from implementation of land use policies and what system improvements could be recommended to accommodate projected travel demand. The data contained in the report will be used in the "Existing Conditions" section of the Transportation Element and the "Setting" section of the Environmental Impact Report. In addition to describing characteristics of the transportation system for the base year, the report also documents trends that led to existing conditions.

II. AUTHORITY FOR TRANSPORTATION SYSTEMS PLANNING

Government Code Section 65302(b) states that the General Plan shall include "a circulation element consisting of the general location and extent of existing and proposed major thoroughfares, transportation routes, terminals, and other local public utilities and facilities, all correlated with the land use element of the plan." The Transportation Element will contain objectives, policies, and implementation measures for the development and maintenance of the transportation system. The Community Facilities Element will contain objectives, policies and implementation measures for public utilities and facilities.

III. EXISTING TRANSPORTATION POLICIES: AN EVALUATION

The transportation policies in the 1982 Countywide Plan were "particularly designed to meet the realities of energy problems and a shrinking funding base." The policies and objectives reflected public concerns and public desires *circa* 1979. They also incorporated the "shoulds" people were feeling at the time: more transit service should be provided; more people should ride transit; more people should carpool, ride bicycles or walk. All of this was with an eye towards energy conservation and efficiency. Policies were grouped under four headings: 1) Transportation and Energy Conservation; 2) Transportation and its Relation to Land Use and Environmental Quality; 3) Transportation Mode Emphasis; and 4) Major Transportation Projects.

Policies concerning energy conservation emphasized encouraging people to use more energy-efficient modes of transportation such as buses, carpools, vanpools, bicycles, and walking. Employers were called upon to assist employees in using alternate modes and adjusting work hours to avoid congestion during the peak commuting period. There was even a land use policy within this group calling for the inclusion of shops to serve residents of newly developed low density areas. The explicit purpose of this land use policy was to minimize long trips.

During the 1980s, energy conservation declined as a concern among American citizens because the price of gasoline declined relative to other prices and supplies became plentiful. Marin residents did not voluntarily shift to energy-efficient modes of travel because they could afford not to. There was little political pressure placed upon local government to encourage people to switch to energy-efficient modes or to implement programs that would encourage people to change their travel behavior. Energy conservation ceased to be a foundation for transportation policy and government action.

In the second section, "Transportation and its Relation to Land Use and Environmental Quality," the primary policy stated: "The scale, location, and pace of development of transportation services should support the Plan's goals of controlled growth and high quality natural environment." To the extent that this policy could be associated with any transportation system improvement, it was generally followed. As traffic congestion increased during the 1980s, modest street improvements were made to relieve congestion. Severe funding shortfalls prevented local government from maintaining the same level of service throughout the decade. The result was that service deteriorated in some portions of the county, primarily on Highway 101 and along the most heavily traveled arterials, such as Sir Francis Drake Boulevard.

In response to anticipated funding shortfalls, increased congestion and increasing interdependence between Marin, Sonoma, and San Francisco counties, elected officials from these counties plus interested regional agencies formed the 101 Corridor Action Committee. Between 1982 and 1988, the committee evaluated transportation system alternatives for both Marin and Sonoma counties. The Committee concluded that a combination of increased bus and ferry service, high occupancy vehicle lanes, and a light rail train would be the most effective and most politically popular solution to the transportation needs of the next twenty years. The Preferred Alternative of the Corridor Study became the foundation of the transportation system proposed in the Marin Sales Tax Expenditure Plan.

The Marin Sales Tax Expenditure Plan was created by the Marin County Transportation Authority, a joint powers public agency charged with creating and implementing the sales tax plan. A proposed one cent increase to the local sales tax would have funded the following improvements:

- A light rail train from Larkspur to Novato;
- Completion of High Occupancy Vehicle Lanes (carpool lanes) on Highway 101;
- Improvements to local streets, local transit service, or other transportation-related projects deemed important by local government;

- Increased paratransit service for the elderly and disabled; and,

- Transportation System Management programs to encourage the use of alternate modes and reduce travel demand during peak hours.

In November of 1990, the voters rejected the proposed sales tax increase by a margin of approximately two to one.

Since the failure of the sales tax measure, the 101 Corridor Action Committee has resumed meeting. They are focusing on what improvements to make on Highway 101 and the Northwestern Pacific right-of-way, a designated transit corridor.

As the 1980s progressed, increasing traffic congestion prompted voters to put pressure on local government to solve traffic problems and reduce development potential to lessen future traffic impacts. Examples of pressure included ballot measures to maintain a certain level of service on local streets (e.g. Sausalito) or reduce development potential in order to reduce deterioration of service (e.g. Tiburon, Mill Valley, Corte Madera, San Rafael). Several cities enacted development moratoriums to revise their General Plans. During the General Plan revisions, a variety of actions were taken to reduce future traffic congestion. In some cities, development potential on remaining vacant land was reduced through downzoning. Several cities began charging traffic mitigation fees for new development. With these fees charged by local government, developers fund transportation system improvements near their projects to help mitigate traffic impacts.

An example of a detailed response to traffic congestion occurred in the city of San Rafael. The City set a level of service at the most congested intersections and then assigned evening peak hour trips to each vacant or redevelopable parcel in the affected areas. The total number of trips does not exceed level of service standards. Proposed development cannot produce more than the number of evening peak hour trips assigned to its parcel and must also pay mitigation fees for needed improvements.

San Rafael also required developers and employers in major new developments to implement Transportation System Management (TSM) programs that encourage employees to use transit, carpools, and bicycles as alternatives to driving alone. Employers also had the option of shifting their hours of operation to keep their employees off the roads during the most congested times of the day. These measures were implemented on a project-by-project basis and applied only to new development, not to the whole city. Some major employers such as Commerce Clearing House and the County of Marin have instituted Transportation System Management programs on a voluntary basis.

Two policies in the Land Use/Environmental Quality section of the Countywide Plan Transportation Element called for expanding energy-efficient modes of transportation, the second of which specified local transit service. While energy conservation, or at least alternatives to the single-occupant automobile as the primary mode of travel, continued to be a concern among Marin residents during the 1980s, Marin residents did not switch to alternate modes. A ballot measure was placed before the voters in 1980 proposing to increase the local sales tax by one-half cent. Half of the proceeds were to be given to the Golden Gate Bridge District for general transit service and half were to be given to the Marin Transit District to increase local transit service. The voters defeated the proposal by a margin of two to one. In 1990, a proposal to increase the local sales tax by one cent was placed before the voters. The tax increase was to provide a light rail train between Novato and the Larkspur ferry terminal, increase local bus service, complete the High Occupancy Vehicle lanes (carpool lanes) on Highway 101, and implement a Transportation System Management program and growth management program. Voters also defeated this tax increase by approximately a two to one margin.

The remaining two policies in the Land Use/Environmental Quality Section addressed transportation accommodations for visitor travel to West Marin. One policy suggested that West Marin communities review their plans and account for increased visitor travel. Subsequent revisions to the West Marin community plans have taken visitor travel into account. The second policy called for developing transportation service to accommodate the maximum number of visitors, while minimizing "disruption to the natural environment." This policy did not result in any programs that increased the number of visitors to West Marin and there have been no transportation system improvements that facilitate access to West Marin, regardless of visitor travel demands.

The third group of policies were listed under the title "Transportation Mode Emphasis." The first four policies called for reducing use of the single-occupant auto with a corresponding increase in the use of other modes. A goal for increasing the use of carpools was established: a 100% increase above 1980 levels for local travel and a 50% increase for transbay travel. Transbay public transit service was to be increased by one-third; local transit service was to be increased according to the 1979 Local Transit Services Plan. The fourth policy stated that "bicycle use and walking should be encouraged as significant modes of transportation..." and "development of a comprehensive system of bicycle routes and amenities should proceed in accord with the Bicycle Plan for Marin adopted by the Board of Supervisors in 1975." These policies were implemented to the extent that funding was available. The policies calling for increased transit service were predicated upon voters passing the 1980 sales tax measure for transit and, in 1990, the sales tax measure for comprehensive system improvements. Voters defeated both measures.

Due to increasing operating expenses, the Golden Gate Bridge District was forced to raise fares and reduce service. This contributed to declining ridership on both local and transbay buses. Local transit service declined until 1984 when the County revised its contract with the Golden Gate Bridge District. In 1984, the County began an annual $600,000 contribution for additional local bus service. Since 1984, ridership has been increasing steadily. Ridership on transbay routes during the morning commute period, between 6:00 a.m. and 10:00 a.m., began rising in 1988 after seven years of decline.

Although goals were established for increasing carpools, no County program for encouraging carpools was established after the plan was adopted (the policy did not specify a target date for achieving increased carpool use). The Golden Gate Bridge District operated a rideshare program until 1987, when the District contracted with RIDES for Bay Area Commuters for ridesharing services. In 1987, the County created a Transportation System Management Task Force to develop a countywide TSM program and accompanying ordinance. Because there has been no funding to implement the program, the program and ordinance have not been implemented.

Within funding constraints, the County has implemented the bicycle plan. The only funding allocated to bicycle (or pedestrian facilities) is approximately $100,000 per year from the Transportation Development Act, Article 3. Although the bicycle plan calls for miles of paths and bikeways to link all portions of the county, progress has been measured in feet. The plan drafted in 1975 did not anticipate the high rates of inflation during the late 1970s and early 1980s. Escalating costs reduced the amount of improvements feasible.

The fifth policy stipulated that Gnoss Field would be the only civilian airport in Marin, limited to only general aviation. The County adopted an Airport Master Plan in 1989 to guide development of Gnoss Field. All other civilian facilities were to be phased out, except the heliport and seaplane base in Richardson Bay. A small private airport in San Rafael has not yet been phased out (the San Rafael General Plan calls for a different land use over the long run).

The first part of the sixth transportation mode policy said: "Auto access to the recreational area of West Marin should not be increased." No improvements have been made on behalf of automobiles. The second part of this policy stated that "all roads to West Marin are considered scenic highways for County planning purposes but official scenic highway designation shall not be sought from the state because it could encourage added auto use by visitors to Marin." The County did not seek official scenic highway designation from the State of California for any road in West Marin.

To further discourage auto travel to West Marin, the seventh policy stated that "all roads in West Marin shall be maintained as two lanes routes with improvements limited to projects for safety purposes only." This policy has been followed.

IV. TRAFFIC FLOW ON HIGHWAY 101

A. MORNING PEAK HOUR

Using vehicle counts collected during 1986, the most recent data for the entire length of the freeway (supplemented by a few counts from 1980) and a description of lane configurations, the following narrative illustrates how traffic flowed south on Highway 101 in 1987 during the morning between 7:00 a.m. and 8:00 a.m. (Caltrans took traffic counts along the entire length of the freeway for the Highway 101 Corridor Study. Since then, only a few counts for specific segments have been made. The 1987 set provides the most consistent and comprehensive data available.) An examination of vehicle counts combined with operational characteristics such as number of lanes, on/off ramps and hills shows how congestion occurs at various points. Vehicle "counts" are actually flows: the number of vehicles per hour. When the text states, "adding to the 3,000 vehicles already on the freeway...," it means that the highway is carrying vehicles past a given point at a rate of 3,000 vehicles an hour. Freeway lanes are designed to carry a maximum of 2,000 vehicles per hour. At the maximum rate of flow, traffic is "bumper to bumper" at slow speeds.

At the Sonoma-Marin border, Highway 101 is a four lane expressway. It becomes a freeway just north of Novato (a freeway is defined as having overpasses to accommodate cross-traffic and restricted access via a limited number of on- and off-ramps while an expressway has intersections). Shortly after the transition, Marin commuters flow onto Highway 101. Residents from Sonoma who work in Marin or San Francisco travel south in the morning in two lanes. As the road widens to permit faster traffic, Marin residents begin converging from two sides: San Marin Drive from the west and Atherton Avenue from the east. Adding to the 3,000 vehicles (per hour) already on the freeway are another 550 from San Marin Drive and Atherton Avenue. At this point commuters may enter the freeway smoothly with little effect on traffic flow. A short mile ahead, 500 more cars enter from De Long Avenue and traffic still flows smoothly. At Rowland Avenue another 500 vehicles enter and cars on the freeway begin to slow down.

While traffic is flowing more or less smoothly along 101, another stream of cars flows along Novato Boulevard towards the freeway. At the South Novato Boulevard on-ramp the cars must merge. The freeway is no wider here than it was at San Marin Drive, yet it carries an additional 1,550 cars. When another 1,000 cars merge from South Novato Boulevard and Highway 37, traffic backs up.

Approximately 1,000 cars leave the freeway at the Ignacio/Bel Marin Keys interchange. Their departure provides much needed relief to congestion and makes the impact of 700 vehicles entering from Ignacio Boulevard more tolerable. Close to 400 vehicles join the flow at Alameda del Prado. Cars slow down as they climb Pacheco Hill.

On the other side of Pacheco Hill, the speed of travel picks up due to the downhill terrain and some vehicles carrying two or more people move to the "High Occupancy Vehicle" (HOV) lane. The HOV lane was extended to Highway 37 in 1990 making Highway 101 four lanes wide in this area. Although freeway capacity has theoretically increased by 33%, not enough carpools use the HOV lane to significantly improve traffic flow in the regular lanes. In the Marinwood area, 870 vehicles enter the freeway while 200 leave the freeway. From this point south to Corte Madera, freeway travel is characterized by considerable merging and exiting, lane changing, and congestion.

In the North San Rafael area, the number of vehicles entering and exiting the freeway is higher than in Novato. The frequency of lane changing necessary to accommodate this flow significantly slows the pace of traffic. At Lucas Valley Road approximately 600 vehicles enter and 850 exit. Manuel Freitas Parkway in Terra Linda is the second road at which more cars exit the freeway than enter; approximately 850 exit while 400 enter. Vehicles that were in the HOV lane must cross three lanes of traffic to exit at either Lucas Valley or Manuel Freitas. Other vehicles must slow down to let them into the lane.

Immediately south of Manuel Freitas Parkway traffic slows dramatically. Some of the worst congestion during the morning occurs at Puerto Suello Hill. Not only is the hill steep, but at the top of the hill four lanes of freeway plus an on ramp must squeeze into three lanes, creating a bottleneck. Nearly 250 vehicles from the Los Ranchitos area and Santa Venetia area enter and simultaneously climb up the steep on-ramp.

Although 750 vehicles exit at Lincoln Avenue and another 2,000 exit at Hetherton Avenue in downtown San Rafael, traffic moves very slowly through San Rafael. The space created by the cars leaving is almost filled up by 2,100 vehicles entering at Hetherton Avenue south of Second Street. At least here there is a long auxiliary lane to allow a smoother weave between those entering and those exiting at Bellam Boulevard (1,600 vehicles exit at Bellam). Immediately south of the congestion at Central San Rafael is another hill, Cal Park Hill, and another on-ramp which delivers 500 vehicles immediately into the right lane.

Identical to the on-ramp at Puerto Suello Hill, those entering the freeway must climb a hill as they try to accelerate into on-coming traffic. To complicate matters, a second off-ramp for Francisco Boulevard is at the same spot. Drivers must weave between cars entering or exiting the freeway at this point. Speeds are usually low at this juncture and the weaving itself further slows already slow traffic at the foot of the hill.

On the south side of the hill 700 vehicles leave the freeway for Kentfield and Larkspur Landing. Ahead, another 1,800 vehicles enter from Sir Francis Drake Boulevard. Another difficult spot for weaving occurs between Sir Francis Drake Boulevard and Lucky Drive. Drivers accelerating downhill towards the exit are met by a stream of cars from Sir Francis Drake Boulevard, which in turn are accelerating to merge with Highway 101.

After the Lucky Drive exit, another High Occupancy Vehicle lane begins. Buses, vanpools and carpools enter the HOV lane and free space for more cars in the left lane. Approximately 500 vehicles enter the freeway at Tamalpais Drive in Corte Madera, a majority of which come from the west side of Corte Madera. At the next ramp, about 1,000 vehicles enter from Mill Valley, Strawberry, Tiburon, and Belvedere. As the freeway crosses the Richardson Bay Bridge, it carries over 6,500 southbound vehicles. Another 1,100 enter from Route 1 in the Tamalpais Valley area and about 300 exit. At the Sausalito/Marin City ramp, fewer than 200 vehicles enter the freeway while 1,100 exit. Slightly more than 5,600 vehicles cross the Golden Gate Bridge.

B. EVENING PEAK HOUR

Traffic flow in the evening is different from the morning, due to slightly higher traffic volumes and different lane configurations on the northbound side of the freeway. During the evening peak hour between 5 p.m. and 6 p.m., 6,500 vehicles flow into Marin (1987 conditions). Almost half of those vehicles leave the freeway for Sausalito, Tamalpais Valley, Mill Valley, and the Tiburon Peninsula. Meanwhile, approximately 1,600 vehicles enter from Sausalito, Tam Valley, and Strawberry. At the Tiburon Boulevard overpass 4,900 vehicles are on the freeway and traffic flows smoothly (except on Fridays when people leave early for the weekend). At the other side of the overpass, 700 cars enter from Tiburon and Mill Valley. With the auxiliary lane between Mill Valley and Corte Madera, the freeway has five lanes and the traffic flows smoothly. Sometimes traffic slows as vehicles change lanes to exit at Paradise Drive.

The first backup of the evening commute occurs south of the Greenbrae interchange. At this interchange, several factors bring traffic to a near standstill. First, approximately 1,500 cars must cross several lanes of traffic to exit at Sir Francis Drake Boulevard. Second, the freeway narrows from four lanes to three. Third, about 850 vehicles enter directly into the right lane via the on-ramp from Larkspur Landing.

At Cal Park Hill between Larkspur Landing and San Rafael, three lanes of freeway carry approximately 6,000 vehicles (recall that at Mill Valley's Alto Hill five lanes carry 5,500 vehicles). There is no relief ahead because 1,400 vehicles enter from Interstate 580 and merge into the left lanes. Also, 1,400 vehicles cross lanes to exit at Downtown San Rafael. Farther north, 1,400 enter from Mission Street.

Fortunately, an auxiliary lane between Mission Street and the Civic Center exit smooths the merge. At Puerto Suello Hill near the Civic Center, the freeway carries 6,400 vehicles. At the peak of Puerto Suello Hill, 1,300 vehicles exit at North San Pedro Road and 230 enter immediately north. The freeway carries 4,800 vehicles between North San Pedro Road and Manuel Freitas Parkway. At this segment, the freeway has three regular lanes, one auxiliary lane, and one High Occupancy Vehicle lane to carry traffic. The flow is relatively smooth. Approximately 400 vehicles enter at Manuel Freitas Parkway, followed by another 500 at Lucas Valley Road.

In the Marinwood area (Miller Creek Road), 200 cars exit and 350 enter. Just north of the Marinwood interchange the freeway carries 6,100 vehicles. Not only are traffic volumes relatively high here, the freeway narrows from five lanes to three. The High Occupancy Vehicle lane that began at Puerto Suello Hill stops at Pacheco Hill just before the Nave Drive exit (the lane has since been extended to Highway 37). The auxiliary lane from Marinwood becomes the Nave Drive exit and creates a bottleneck similar to the one at Cal Park Hill. Traffic usually backs up to the Lucas Valley Road interchange because of this bottleneck. A 1991 count at the Marin-Sonoma County line showed 4,039 vehicles in the evening peak hour, indicating severe congestion; additional counts will be made for the northern portion of the county in the winter of 1991.

Table 1 lists traffic volumes and Level of Service (LOS) at selected points along Highway 101 for both morning and evening peak hours. The volumes shown for the morning peak hour are for southbound traffic; evening peak hour volumes are for northbound traffic. Volumes were counted by the California Department of Transportation (Caltrans) between March and September of 1986 as part of the 101 Corridor Study. Morning peak hour is between 7:00 a.m. and 8:00 a.m. Evening peak hour is between 5:00 p.m. and 6:00 p.m.

Level of Service (LOS) is a letter grade indicating the quality of traffic flow on the freeway. Level of Service A denotes free flow with few vehicles and easy maneuverability. Level of Service F denotes severe congestion with bumper-to-bumper traffic at slow speeds.

Table 1. Traffic Volumes and Level of Service on Highway 101, 1986

	Morning Peak Hour		Evening Peak Hour	
Location	Volumes	Level of Service	Volumes	Level of Service
Sonoma County Border	2,793	C	N/A	
Miller Creek Rd./Alameda del Prado	N/A		5,961	E
San Pedro Road/Los Ranchitos Road	6,364	F	4,456	C
Seminary Drive/Route 1	6,490	D	4,934	B
Golden Gate Bridge	5,665	C	6,514	D

NOTE: The counts were made between April and September of 1986. These are for specific dates - Caltrans did not calculate "average peak hour" volumes for the study period. Volumes are actually a flow measured as vehicles per hour.

Source: California Department of Transportation: *The Marin 101 Corridor Study, 1986 Traffic Counts*, December 1986.

V. TRAFFIC ON SELECTED ARTERIALS

Arterials are signalized streets that primarily serve through traffic and provide access to adjacent property. They may be two-, four- or six-lanes wide depending on the volume of traffic they are designed to carry. Although the number of lanes, on-street parking and intersecting driveways affect traffic flow on arterials, intersections are the greatest influence on traffic flow. When an arterial intersects another arterial or collector street, there are usually stop lights or stop signs to regulate vehicle flow. A measure of flow along an arterial is volume-to-capacity ratio at the intersection: how many vehicles may travel through the intersection, including those making turns, compared to the ability of the intersection to handle the flow. The volume-to-capacity ratio itself is a two-digit decimal representing the quotient of the theoretical capacity of the intersections divided by the number of vehicles flowing through the intersection. The design of an intersection is the key determinant in its ability to handle the flow. Design components include such items as the number of lanes, special left turn lanes, signal phasing, length of red and green cycles, and "right turn on red."

The volume-to-capacity ratio may be converted to a Level of Service (LOS) designation, a letter grade indicating the quality of traffic flow through an intersection. Level of Service A denotes free flow with few vehicles and easy maneuverability. Level of Service F denotes severe congestion, long waits and slow speed (actually bumper-to-bumper). In most suburban towns, elected officials have chosen Level of Service D as an acceptable performance standard. Level of Service D is characterized by some delay, restricted maneuverability, and some difficulty making left turns. Level of Service D has also been a long term goal for Highway 101.

A. WEEKDAY PEAK HOUR CONDITIONS

Table 2 on the following page lists Level of Service and volume-to-capacity ratios for elected intersections throughout Marin County during the morning and evening peak hours. (Usually, roads are most congested during the evening peak hour.) The Level of Service grade indicates the quality of traffic flow along the arterial. The dates of the counts range from 1979 to 1989. It is possible that traffic has increased since the dates of the earlier counts, but the amount of increase is unknown. Also, some intersections have been improved during the 1980s, which may have raised the Level of Service.

Table 2. Level of Service at Selected Intersections, 1987
Level of Service (LOS), Volume-to-Capacity Ratio (V/C)

	Morning Peak Hour		Evening Peak Hour		
Intersection	LOS	V/C	LOS	V/C	Source
NOVATO AREA:					
San Marin & Redwood Highway	A	.56	C	.71	1
San Marin & Southbound 101 ramp	A	.56	A	.44	1
San Marin & Northbound 101 ramp	A	.39	B	.62	1
Atherton & Binford	A	.45	A	.50	1
Atherton & Bugeia	A	.41	A	.39	1
Ignacio & Sunset Parkway	A		A		2
Ignacio & Alameda del Prado	E/E		B/E		2
SAN RAFAEL AREA:					
Smith Ranch Road & Redwood Highway			A	.55	3
Smith Ranch Road & Northbound 101 off ramp			A	.51	3
Lucas Valley Road & Southbound 101 ramp			B	.63	3
Lucas Valley Road & Los Gamos Road			B	.67	3
Lucas Valley Road & Las Gallinas Road			A	.41	17
Manuel Freitas & Las Gallinas Road			A	.55	17
Bellam Boulevard & Highway 101			D		9
Bellam Boulevard & East Francisco Boulevard			D		9
Bellam Boulevard & Kerner Boulevard			B		9
Second Street & Grand Avenue			D		9
North San Pedro & Civic Center Drive			A	.46	12
North San Pedro & Merrydale Road			C	.73	12
Civic Center Drive & Redwood Drive (near Manuel Freitas)			C	.74	12
ROSS VALLEY AREA:					
Sir Francis Drake & Bon Air			C	.73	11
Sir Francis Drake & College	D	.89	D	.83	7
Sir Francis Drake & Wolfe Grade	E	.92	D	.83	7
College & Kent & Woodland	A	.59	D	.84	7
Sir Francis Drake & La Cuesta	C	.74	F	1.09	6
Sir Francis Drake & Éliseo Drive	E	.91	F	1.02	6
Sir Francis Drake & Southbound 101 ramp	A	.41	A	.42	6,8
Sir Francis Drake & Northbound 101 ramp	A	.56	D	.83	6,8

Table 2 (continued)

Intersection	Morning Peak Hour LOS	V/C	Evening Peak Hour LOS	V/C	Source
Sir Francis Drake & Larkspur Landing (west)	A	.55	C	.72	6
Sir Francis Drake & Larkspur Landing (east)	B/E		F/F		6
Sir Francis Drake & Andersen Drive	A/E		C/E		6
Bon Air & South Eliseo Drive			C	.72	11
Bon Air & Magnolia			A	.58	11
Tamalpais Drive & Madera Boulevard			A	.44	16
Tamalpais Drive & 101 ramp Southbound			A	.56	16
Tamalpais Drive & 101 ramp Northbound			A	.49	16
Redwood Avenue & Corte Madera Avenue			E	.91	16
SOUTHERN MARIN AREA:					
Tiburon Boulevard & East Blithedale	B		B		4
Tiburon Boulevard & Redwood Frontage Rd.			D	.88	15
Tiburon Boulevard & Northbound 101 ramp	A		A		4
Tiburon Boulevard & Strawberry Drive			A	.54	15
Tiburon Boulevard & Greenwood Cove			C	.71	15
Tiburon Boulevard & Lyford Drive	B		B		4
Tiburon Boulevard & Trestle Glen	B		B		5
Tiburon Boulevard & Beach Road	A		A		4
Tiburon Boulevard & Mar West			B/A		4
Paradise Drive & Mar West			A		4
Bridgeway to Southbound 101 ramp			D		14
Bridgeway & Gate 6 Road			B	.67	10
Bridgeway & Gate 5 Road			A	.46	10
Bridgeway & Coloma			A	.56	10
Bridgeway & Harbor			B	.65	10
Bridgeway & Nevada			A	.36	10
Bridgeway & Napa			B	.61	10
Bridgeway & Caledonia			A	.51	10
Bridgeway & Anchor			A	.41	10
Bridgeway & Princess			A	.42	10
Bridgeway & Bridge Boulevard			B	.61	14
Donahue to Bridgeway			D		14
Donahue to Southbound 101 ramp			E		14
Route 1 & Almonte			D	.87	13
Miller & Camino Alto			A	.59	13

Table 2 (continued)

Intersection	Morning Peak Hour LOS	V/C	Evening Peak Hour LOS	V/C	Source
Blithedale & Camino Alto			C	.70	13
Southbound 101 ramp & Route 1			D/E	.88	13
Route 1 to Southbound 101 ramp			A		13
Northbound 101 ramp & Pohono			C/D	.81	13
Northbound 101 ramp from Tamalpais Drive			C		13

NOTE: Blank spaces in the table indicate that data were not reported.

SOURCES:

1. LSA Associates: Rush Creek Estates Traffic Study, March 19, 1990.
2. EIP Associates: Draft EIR Hamilton Field Master Plan, Sept. 1986, page 3-70.
3. John Roberto: Ross General Hospital EIR, July 17, 1987.
4. Earth Metrics: Marinero Estates EIR, May 1989, page 3.4-6.
5. Town of Tiburon: Tiburon General Plan, September 1988, page 16-10.
6. Michael Clayton & Assoc.: Landmark Plaza EIR, 1988, page 3-18, 19.
7. TKJM: Kentfield Transportation Study, July 1983, page 10.
8. Parsons Brinckerhoff: Greenbrae Interchange Study, 1985.
9. City of San Rafael: East San Rafael Neighborhood Plan, 1985.
10. DKS Assoc.: Sausalito Transportation/Circulation Study, December 1983.
11. Nichols Berman: Marin General Hospital Draft Focused EIR, April 1985, page 41.
12. Wilbur Smith: Civic Center North Hotel Traffic Impact Study, March 1988 as reported in EIP Assoc.: Marin County Correctional Facility Draft EIR.
13. John Roberto Assoc.: Tamalpais Area Community Plan (Draft), 1990, page IV-9.
14. Nichols Berman: Marincrest Master Plan Draft EIR, February 1984, page 167.
15. EIP Assoc.: Cypress Hollow Master Plan EIR, March 1988, page 3-22.
16. Wilbur Smith and Associates: Corte Madera Townwide Traffic Study, October 1987, page 6.
17. City of San Rafael Public Works Department.

B. WEEKEND TRAFFIC CONDITIONS

Although the heaviest congestion usually occurs during the evening commute period on weekdays, congestion also occurs during weekends in the Tamalpais Valley area, and between Fairfax and the San Geronimo Valley. Visitors to Muir Beach, Stinson Beach, Muir Woods, and Mount Tamalpais contribute significantly to congestion on State Route 1 through Tamalpais Valley. A 1990 traffic study showed that the total volume of traffic passing through the intersection of State Route 1 and Almonte Boulevard, known as Tam Junction, was 2,197 vehicles during the weekday evening peak hour and 2,030 vehicles during the weekend peak hour. The congestion experienced in the intersection is worse during the weekend, however, because more vehicles are turning left to go to the recreation areas. This situation results in a lower Level of Service during the weekend: D as compared to C during the evening peak hour.

A 1985 study of traffic conditions at White's Hill between Fairfax and San Geronimo showed a Level of Service D for the peak hour, Sunday evening between 6:00 p.m. and 7:00 p.m. Just over 1,000 vehicles per hour were measured on a two lane rural road.

VI. TRANSIT SERVICE AND ALTERNATE MODES

A. TYPES OF PUBLIC TRANSIT SERVICE

The Golden Gate Bridge District provides six types of transit service: Basic, Commute, Recreational, Ferry Feeder, Local, and Special.

Basic Service consists of four routes upon which buses travel all day, seven days a week. It serves selected areas of Marin and takes passengers to the Transbay Bus Terminal and the Civic Center in San Francisco. Currently, 274 runs are made along these four routes during a weekday, with 193 runs on the weekend.

Commute Service operates on 17 routes between Marin and Sonoma neighborhoods and the San Francisco Financial District and the Civic Center. Buses are operating only during commute periods, between 6:00 a.m. and 10:00 a.m., and 3:00 p.m. and 7:00 p.m. Unlike basic service, commute buses circulate only through a particular neighborhood or area and then travel non-stop to San Francisco on Highway 101. During commute periods 339 runs are made.

In November of 1990, the Golden Gate Bridge District began a new type of commute service. Eleven buses on three routes pick up passengers at selected locations in Sonoma and take them non-stop to selected employment sites in Marin, between the hours of 5 a.m. and 9 a.m., and 3 p.m. and 7 p.m. Employers at participating sites

have helped the Bridge District with route planning and scheduling, and they have also offered ticket discounts to employees to encourage ridership. As of April 1991, approximately 500 people per day were using the service.

Recreational Service is limited to two routes serving park and recreation areas, primarily in West Marin. Connections are made with other bus routes at selected stopping points. Twelve runs are made on each Saturday and Sunday, but not weekdays.

Ferry Feeder Service consists of twelve routes connecting selected neighborhoods with the Larkspur, Tiburon, and Sausalito ferries. As with commute service, these buses operate only during the morning and afternoon commute periods, for a total of 86 runs per day.

Local Service is provided under contract with the Marin County Transit District and several school districts. Twelve routes take Marin residents to various points within Marin but not to San Francisco. A total of 227 local service runs are made within Marin.

Special Service is provided on five routes for sporting events, fairs, and other infrequent events. These buses operate only on the day of the event. Special service also includes a shuttle between the Golden Gate Bridge toll plaza and San Francisco Civic Center, and between downtown San Rafael and the Bridge District bus facility in East San Rafael.

Bus fares are grouped into fare zones, corresponding to the distance traveled between zones. There are nine zones with the northernmost zone around Santa Rosa, and the westernmost zone around Inverness. The lowest fare is $1.00 for a trip within a zone or to an adjacent zone. The highest fare is $3.70 for a trip from Santa Rosa or Inverness to San Francisco. Within Marin, fares rise 35 cents across each zone line. The fare rises by a larger amount, 70 cents to $1.10, depending on zone of origin, when the Sonoma County line is crossed.

The Golden Gate Bridge District also operates two ferry routes. Between Larkspur and San Francisco, three 725-passenger boats (532 seats) make 26 crossings during weekdays and 10 crossings on weekends and holidays. The fare (July through November, 1991) is $2.20 each way on weekdays and $3.00 each way on Saturday, Sunday and holidays. Between Sausalito and San Francisco a 575-passenger ferry (396 seats) travels eighteen times a day (nine round trips). There are twelve crossings on weekends and holidays. The fare is $3.50.

B. PUBLIC TRANSIT RIDERSHIP

Statistics from the Golden Gate Bridge District show that transit ridership to San Francisco during the commute period has declined since 1980. Average daily ridership for Local Service within Marin declined between 1980 and 1990. By contrast, Basic Service patronage increased during those years.

During the morning commute period, between 6 a.m. and 10 a.m., bus ridership into San Francisco has fallen from 9,907 passengers in Fiscal Year 1980 to 6,971 in 1990 (a decline of 30%; this includes both basic and commute service). Ferry ridership dipped somewhat during the early 1980s but has increased in recent years. Ferry ridership was 1,728 passengers in 1980. It dipped to 1,053 in 1983, but rose to 1,797 by 1990. In 1990 commuter buses carried 20% of the transbay commuters, and the ferries carried 4.7%. The loss in transit ridership during the morning is due to decreased automobile operating costs (e.g. lower prices for gasoline), ample affordable parking, and increased transit fares. The result has been more driving, especially by people who drive alone. The number of people driving alone to San Francisco increased steadily between 1980 and 1990, from 14,903 to 17,264. Two- and three-person carpools have been declining.

Between 1980 and 1990 patronage within Marin declined on local service routes. As shown in Table 3, average daily ridership dropped from 5,713 to 3,364. During the same period, patronage of basic service within Marin increased. Ridership to San Francisco increased slightly for local service but declined for basic service.

Table 3. Transit Ridership for Local, Basic, and Recreation Service Average Daily Person Trips (Fiscal Years 1980 and 1990)

	WEEKDAY		WEEKEND	
	1980	**1990**	**1980**	**1990**
LOCAL SERVICE				
Within Marin	5,713	3,364	1,288	494
To San Francisco	282	300	108	39
BASIC SERVICE				
Within Marin	4,539	6,502	2,693	4,269
To San Francisco	5,178	4,206	3,759	2,848
RECREATION SERVICE				
Within Marin			94	41
To San Francisco			133	22

Source: Golden Gate Bridge District

C. SPECIALIZED TRANSIT SERVICE

Greyhound Lines, Inc. provides intercounty bus service from its terminal in San Rafael. There are three northbound and three southbound departures each day. The northbound buses originate in San Francisco and terminate at Crescent City, Vancouver and Seattle. The southbound buses originate in Crescent City, Vancouver, and Portland, and terminate in San Francisco.

Ridership estimates were sent from Greyhound headquarters in Des Moines, Iowa for the month of June, 1990. The total was 252 trips departing from San Rafael and 113 trips arriving. However, Greyhound does not keep summary statistics for each of its terminals and the June 1990 tabulation may be representative of a summer month. The number of trips in winter may be lower, except for holidays.

The Marin Airporter, based near Larkspur Landing, provides regularly scheduled service to and from the San Francisco airport. Buses depart every half hour between 4:30 a.m. and 11:00 p.m. The Airporter makes six stops along Highway 101 in Marin: the Spencer del Mar exit bus pad at the top of Waldo Grade, the Manzanita Park and Ride lot at the intersection of Route 1 and Highway 101, the Seminary Drive bus pad in Mill Valley, the Holiday Inn Marin in Terra Linda, the Alvarado Inn in Ignacio, and Denny's restaurant in Novato. Ridership averages between 25,000 and 30,000 passenger trips per month. The Santa Rosa Airporter also makes three stops in Marin for trips to and from the San Francisco Airport.

D. PARATRANSIT SERVICE

Paratransit is defined as the various modes of travel and transportation services that fall between conventional transit (buses and trains) and the private automobile. The vehicles may be automobiles, vans, or buses. The key distinction is the type of service provided. Services are divided into three categories: 1) hire and drive; 2) hail or phone; and 3) prearranged ridesharing.

Hire and drive is more commonly know as the rental car business. A customer pays for a vehicle for a definite period of time, agrees to pick up and return the vehicle at designated places, and operates the vehicle under terms specified in a contract.

Hail or phone services include dial-a-ride, the common taxi, and the almost extinct jitney. Taxi provide door-to-door service in response to a customer call. Usually only one customer uses the cab at a time and rarely does the cab pick up another customer while taking someone to his or her destination. Jitneys are small buses or vans which follow fixed routes but may deviate from those routes according to the passenger or driver preferences.

Prearranged ridesharing includes carpools, van pools, club buses (a large vanpool), and taxi-like services provided on a contract basis. Being the least familiar of the locally provided paratransit services in Marin, prearranged ridesharing will be more thoroughly described.

Prearranged ridesharing services are provided by the Marin Senior Coordinating Council (MSCC) and the Volunteer Center of Marin. Under contract with various agencies and organizations, the Marin Senior Coordinating Council offers rides to elderly and disabled people when they call, delivers meals to shut-ins, and transports people to organized activities. Various agencies and organizations pay some of MSCC's costs so that the passenger does not have to bear the full cost of the services. The contracts which these agencies sign with MSCC state how much service they expect from MSCC and amount of reimbursement.

MSCC operates its vehicles between the hours of 8:00 a.m. and 5:00 p.m. Most of the trips are in the eastern, urban portion of the county, but there are weekly and bi-weekly trips to Bolinas, Point Reyes, Tomales, and Dillon Beach. Potential customers must arrange for their rides at least two hours in advance and may reserve a ride up to three days in advance. This latter practice is common for doctors' appointments and other important trips.

During fiscal year 1990 MSCC provided a total of 91,410 passenger trips, 61,222 under contract to the County of Marin and 30,188 under contract to various other organizations. According to a January 1987 survey, 48% of all trips (in 1986) were for medical appointments. Other trips included recreation (17%), therapy (15%), shopping (12%), work (5%) and school (3%). (1987 was the last survey and MSCC does not keep annual statistics of trip purposes.)

The Volunteer Center of Marin recruits volunteers to transport elderly and disabled people who may not have any other alternative service. Service is provided between 9:00 a.m. and 5:00 p.m. Monday through Friday. The Volunteer Center reimburses drivers for mileage and provides insurance. Approximately 2,500 trips per year include medical and therapy appointments as well as trips for recreation, meetings, and visits to institutional services (e.g. day care).

Ridesharing services for work-related trips are provided by RIDES For Bay Area Commuters and major employers. These services consist of matching people for carpools, van pools, and club buses. RIDES also assists groups of commuters who would like to organize their own vanpool or club bus. The vehicles may be either purchased or leased by the employer or by a group of commuters. Companies wanting a transportation coordinator to help employees with commuting may have RIDES train someone for that position.

By facilitating carpooling, these ridesharing services have great potential for reducing the number of vehicles on roads during the most congested times of the day.

E. CARPOOLING

An indication of carpooling in Marin and Sonoma Counties is available from Travel Patterns in Marin and Sonoma Counties, Technical Report #2 of the Transportation Element. In 1987 a survey of Marin and Sonoma households was undertaken to obtain information about local travel. For purposes of the survey a carpool was defined as two people in an automobile (not a van or bus). For the entire sample of 1,507 trips, 16% were in carpools. For Marin residents, 13.5% percent of the trips were made in carpools; 23.5% of Sonoma residents reported carpooling. These trips were made during the evening peak period between 4:00 p m. and 7:00 p.m.

During 1986, Caltrans took traffic counts on Highway 101 for the 101 Corridor Study. Included in this study were vehicle occupancy counts such as the number of carpools with two, three or more persons in them. Table 4 shows the number of carpools with two, three, or more people. Also shown is the carpools' percentage of total vehicular traffic.

Table 4. Carpools on Highway 101, 1986
Number and Percentage of Vehicles
Evening Peak Hour: 5:00 p.m. to 6:00 p.m.

	Two-person Carpools		Three-person Carpools	
Location	**Number of Vehicles**	**Percent of Total**	**Number of Vehicles**	**Percent of Total**
North end of Golden Gate Bridge	1160	20.3	314	5.5
Tiburon Boulevard/East Blithedale	799	16.2	275	5.6
Puerto Suello Hill at San Pedro Rd.	819	18.4	193	4.3
Pacheco Hill north of Miller Creek Rd.	939	15.7	164	2.7

SOURCE: California Department of Transportation, *Marin 101 Corridor Study, Listing of 1986 Traffic Counts*

Unfortunately, Caltrans did not do a similar study in 1980 with which to compare the 1986 data. The only indicator of long-term trends in carpooling is from occupancy counts at the Golden Gate Bridge performed by the Bridge District. The district counts the number of carpools going into San Francisco between 6:00 a.m. and 10:00 a.m. weekdays. In the *Five Year Transit Development Plan* published in 1988, the Bridge District reported that the number of two-person carpools declined from 4,171 in fiscal year 1980 to 3,820 in fiscal year 1987. As a percentage of total vehicles, two-person carpools declined from 19.7% to 16.1%. The number of three-person carpools also declined, 1,534 to 1,054; yet as a percentage of total vehicles, three-person carpools remained constant at 3.6%. By contrast, the number and percentage of single-occupant vehicles rose: 14,930 to 18,442 (70.7% to 77.5%).

During 1988, the Marin County Board of Supervisors asked Caltrans to test whether reducing the vehicle occupancy requirement for using the carpools lanes would encourage carpooling and ease congestion in the other lanes of Highway 101. Since October 1988 Caltrans has been allowing two-person carpools to use the carpool lane (previously only three or more occupant vehicles could use the lane).

At the end of the study period, March 1989, Caltrans concluded: "The increased number of vehicles in the HOV lane on Marin-101 appears to be primarily a direct shift of existing two-person carpools into the HOV lane, combined with former 3+ carpools and vanpools switching to a two-person carpool mode. HOV lane and mixed flow volume data collected before and during the trial does not appear to show any new carpooling growth, or increase in carpooling, on Marin-101 due to the change in occupancy requirement."

In effect, reducing the occupancy requirement allowed two-person carpools to travel in the faster carpool lanes, but did not induce people who drive alone to pick up an additional passenger. An important caveat to the discussion of carpooling is that there are only two relatively short segments of carpool lanes in Marin. There are no carpool lanes from Larkspur Landing to the County Civic Center, the most congested portion of the freeway. If carpool lanes were provided throughout the county, their advantages in travel time might encourage more carpooling.

Table 5 shows total vehicle volumes at two points along the high occupancy vehicle lanes. The volumes were collected for the evening peak period between 3:00 p.m. and 6:00 p.m. and are for northbound traffic only.

Table 5. Vehicle Occupancy on Highway 101
(September 1988 - February 1989)

Occupancy (persons/vehicle)	September 1988	Percent of Total	February 1989	Percent of Total
Location: Tiburon Boulevard Interchange				
1 Person	14,180	80.0%	15,320	80.1%
2 Persons	2,710	15.3	3,180	16.6
3+ Persons	580	3.3	400	2.1
Buses	160	0.9	180	0.9
Vanpools	90	0.5	50	0.3
TOTAL	17,720	100.0%	19,130	100.0%
Location: Between Manuel Freitas Parkway and Lucas Valley Road				
1 Person	14,780	77.8%	19,290	80.9%
2 Persons	3,240	17.0	3,880	16.3
3+ Persons	800	4.2	490	2.1
Buses	110	0.6	130	0.5
Vanpools	70	0.4	60	0.3
TOTAL	19,000	100.0%	23,850	100.1%

Source: California Department of Transportation, *Marin 101: 2+ HOV Lane Occupancy Trial Period.*

F. BICYCLE USE

The only recent information about bicycle use for commuting is contained in Travel Patterns in Marin and Sonoma Counties, Technical Report #2 of the Transportation Element. This 1987 survey of 1,034 households (793 in Marin, 241 in Sonoma) asked about travel during the evening peak period, between 4:00 p.m. and 7:00 p.m. Of the 1,507 trips made during the peak period only five were made by bicycle (3 in Marin and 2 in Sonoma).

VII. AIRPORT FACILITIES

Marin has one general aviation airport at Gnoss Field north of Novato. Marin Ranch Airport is small craft private airport in northern San Rafael. There is also a military air base at Hamilton Field in Novato. Gnoss Field has a 3,300 foot asphalt runway which can accommodate small private aircraft (under 12,500 pounds gross weight maximum). It is classified by the Federal Aviation Administration as a "Basic Utility, Stage II" facility and a "reliever" airport. Basic Utility, Stage II means that the airport can handle approximately 95% of single and twin engine personal and business planes. "Reliever" means that Gnoss Field would be expected to handle small planes that could not land at Oakland or San Francisco airports in situations with excessive demand.

According to the *Airport Master Plan for Marin County Airport* (June, 1989) by Cortright & Seibold, Gnoss Field has parking space for 299 aircraft. As of May 1988 there were 260 aircraft based there. Since 1980 the number of based aircraft rose from 248 to a high of 303 in 1983, before declining to 260 in 1988. Although the airport manager does not count the number of takeoffs or landings, Cortright & Seibold estimates between 135,000 and 160,000 takeoffs and landings per year.

Marin Ranch Airport is a private airport with 112 aircraft. The owners submitted an application to the City of San Rafael for a three-year use permit extension. If or when Marin Ranch closes, many of the resident aircraft are expected to relocate to Gnoss Field, since the San Rafael General Plan designates the property for non-aviation uses.

Hamilton Air Force Base, jointly owned by the U.S. Navy, Coast Guard, Army and State of California, supports military operations, and, if necessary, disaster relief. The portion of the base not necessary for Army Reserve use has been recommended for surplus by the Federal Commission on Base Realignments and Closures (for approximately 695 of the 1,500 acres). Both the County of Marin and City of Novato have policies opposing use of Hamilton for general aviation purposes. In 1984, voters in Novato defeated an initiative to allow general aviation use.

VIII. THE TRANSPORTATION MODEL

The Marin County Public Works Department developed a microcomputer-based mathematical model of the transportation system in the Bay Area. The model was designed to simulate travel behavior in the Bay Area with particular emphasis on Marin, San Francisco, and Sonoma Counties. Using information about land use, employment and demographic characteristics of the population, the model estimates average daily traffic volumes and morning and evening peak hour volumes on a schematic road network. Output also includes estimated speeds and volume-to-capacity ratios on road segments.

Because the transportation model works with the entire nine-county Bay Area, it is a large scale model. Its purpose is to help traffic engineers study performance of the transportation system countywide. Because some of the worst traffic congestion occurs on Highway 101 and its interchanges, the model was prepared primarily to analyze Highway 101 and interchanges, not local streets. The questions the model is designed to answer are those involving major capital expenditures and other large scale changes. Typical questions include: "How would adding a lane to the freeway improve traffic flow? How many people would ride a train between Marin and Sonoma? How would different amounts of development affect future traffic conditions? How would a different mix of jobs and housing influence travel patterns?" The model cannot answer questions about traffic within a neighborhood nor the impact of small scale development such as a new office building on local streets.

The limitations of software, the availability of data to calibrate the model, and the cost per model run necessitate simplifications to the transportation system used in the model. Within Marin County, the system consists of Highways 101 and 37, State Routes 1 and 131 (Tiburon Boulevard) primary arterials, selected secondary arterials, and transit routes. The county was divided into 114 traffic zones encompassing residential neighborhoods, major employment centers, and commercial areas. In San Francisco and Sonoma counties, a less detailed road network is combined with fewer traffic zones. In the remaining six Bay Area counties a skeletal highway network and 24 traffic zones are used.

Given the simplifications necessary for computer modeling of traffic, it is important to remember that the results are estimates and that they are influenced by the configuration of the model road network and road segment capacities. The following discussion must be kept in mind when reviewing model results.

Evaluating the performance of a model requires comparing its output with actual vehicle counts on the corresponding road segments. Several factors influence the actual counts, and several more influence the model-estimated counts. First, experience has shown that actual counts may vary by $\pm 10\%$ on a daily basis. There are also seasonal variations. For example, more traffic occurs during the summer or school sessions. Second, traffic capacity may vary according to the physical conditions on the road. Vehicles parked on the side of the road may slow drivers, reducing traffic capacity below that expected if there were no parking. The number of drivers entering the road from driveways, pedestrian crossings, the number of intersections and how traffic is regulated at intersections influence capacity significantly. The number of alternate routes may affect counts on specific segments, especially during peak commute hours. Drivers may take a "back road" to avoid a congested segment. In sum, traffic counts reflect daily and seasonal variations as well as a driver's decision about which routes are the quickest based on perceived congestion and travel speed.

Due to the simplifications necessary for modeling, the above mentioned physical and operational factors cannot be represented in the same detail. In the model, the capacity of a segment is calculated according to the number of lanes and type of facility. It is measured for the number of vehicles per hour per lane. The capacities used to interpret the results of the model were: freeways, 2,000 vehicles per hour; divided arterials, 1,000 vehicles per hour; undivided arterials, 800 vehicles per hour.

The model estimates demand for road space based on the number of trips generated by land uses and the mode choice of trip makers (e.g. drive alone, carpool, transit). The model assigns vehicles to the network based on segment capacity and calculated vehicle speeds on the segments. As demand reaches capacity the model lowers speeds for the affected segments and looks for alternate routes with higher speeds. It does this in successive iterations until the speeds calculated for each segment are in equilibrium, i.e., any route taken between two traffic zones will have the same calculated travel time. Because the model works with demand and supply on a segment basis, it may assign more vehicles to a road segment than can actually be accommodated. The model will report high volume to capacity ratios and very low speeds. This indicates a bottleneck at the affected segment. The model *does not* show the effects of a bottleneck where traffic backs up on adjacent segments.

The simplified road network used in the model eliminates many roads, some of which may be alternate routes. Also, due to the simplified road network, a traffic zone often has fewer segments connecting it to the road network. Actually, there may be many outlets from the same neighborhood represented by that traffic zone. Combined with the placement of the road segment that connects the traffic zone to the road network, the limit of only a few connector roads significantly influences estimated traffic of some road segments. It is the role of the traffic engineer to note the discrepancies between the physical layout of real streets and their schematic representation in the model and account for the differences.

This discussion serves to set a context for reviewing the model results. It is important to keep in mind that the simplifications necessary for modeling may produce results that are not accurate for some road segments. This is especially true when a street has many changes along its length which cannot be represented in sufficient detail in the model.

The primary indicators of transportation system performance as shown by the model are volume-to-capacity ratio and level of service. Volume-to-capacity is the same as demand and supply, the number of vehicles assigned to a segment divided by the vehicular capacity of that segment. For example, if the assigned volume is 1,500 vehicles and the segment capacity is 2,000 vehicles, the volume to capacity ratio is 0.75. This ratio is converted to a letter grade called Level of Service (LOS).

The letter grades range from A to F, with Level of Service A representing excellent travel conditions and Level of Service F representing severe congestion. Table 6 shows the relationship between Level of Service grades and volume-to-capacity ratios.

Table 6. Level of Service, Volume-to-Capacity Ratios

	Level of Service	Volume-to-capacity Ratio
For Highways:	A	0.00 - 0.35
	B	0.36 - 0.54
	C	0.55 - 0.77
	D	0.78 - 0.93
	E	0.94 - 1.00
	F	1.00+

Source: Transportation Research Board, *Highway Capacity Manual*, Chapter 3

	Level of Service	Volume-to-capacity Ratio
For Local Streets:	A	0.00 - 0.60
	B	0.61 - 0.70
	C	0.71 - 0.80
	D	0.81 - 0.90
	E	0.91 - 1.00
	F	1.00+

Source: Transportation Research Board, *Circular 212*

A. TRANSPORTATION SYSTEM CAPACITY: HIGHWAY 101

The capacity of a typical standard freeway lane is 2,000 vehicles per hour. For the purpose of this analysis, the standard capacity is reduced for those locations with lane width narrower than 12 feet and with a significant change in roadway grade. The procedures used to adjust from standard capacity are given in the Highway Capacity Manual. Table 7 shows adjustment factors for several points along Highway 101.

A second adjustment to the capacity of a standard freeway lane is provided for High Occupancy Vehicle (HOV) lanes and auxiliary lanes. The capacity of these lanes is assumed to be one-half of the capacity of a standard freeway lane. This assumption is based on the historic use of these kinds of lanes rather than on actual physical dimensions. Typically, these lanes rarely carry more than about 1,000 vehicles per hour. The total capacity of the freeway for each of the segments between the Golden Gate Bridge and the Sonoma County line is shown for 1991 in Tables 8.

Table 7. Calculation of Highway 101 Adjustment Factors

Highway 101 Location	Adjustment For:	Factor
Golden Gate Bridge		
	Lane Width (Table 3-2) 10 ft @>6' Clear.	0.89
Sausalito Lateral to Spencer		
	Lane Width (Table 3-2) 11 ft @>6' Clear.	0.96
	Grade - Table 3-4 thru 3-9	
	Assume - Trucks+Buses+RVs = 2%	
	Grade - 6% for 1/2 - 3/4 mile	
	Passenger Car Equivalents = 11	0.83
Alto Hill (Between Mill Valley and Corte Madera)		
	Grade - Table 3-4 thru 3-9	
	Assume - Trucks+Buses+RVs = 2%	
	Grade - 5% for 1/4 - 1/2 mile	
	Passenger Car Equivalents = 8	0.88
Cal Park Hill (Between Sir Francis Drake Boulevard and Interstate 580)		
	Grade - Table 3-4 thru 3-9	
	Assume - Trucks+Buses+RVs = 2%	
	Grade - 2% for 1/2 - 1 mile	
	Passenger Car Equivalents = 8	0.93
Puerto Suello Hill (Between Mission Avenue and Lincoln Avenue)		
	Grade - Table 3-4 thru 3-9	
	Assume - Trucks+Buses+RVs = 2%	
	Grade - 5% for 1/2 - 1 mile	
	Passenger Car Equivalents = 12	0.82
Pacheco Hill (Between Miller Creek Road and Alameda del Prado)		
	Grade - Table 3-4 thru 3-9	
	Assume - Trucks+Buses+RVs = 2%	
	Grade - 2% for 1/2 mile	
	Passenger Car Equivalents = 8	0.93

Source: Highway Capacity Manual, 1985

Table 8. Calculation of Capacity on Highway 101, Northbound Peak Period, 1991

Highway 101 Location	# of Mixed Flow Lanes	Capacity per Lane	Mixed Flow Capacity	# of HOV/ Aux. Lanes	Capacity per Lane	HOV/Aux Capacity	Total Capacity
*Golden Gate Bridge	4	1780	7120	0			7120
*Sausalito Lateral to Spencer Avenue	4	1594	6374	0			6374
Marin City to State Route 1	4	2000	8000	1	1000	1000	9000
Richardson Bay Bridge	3	2000	6000	2	1000	2000	8000
Seminary Drive to Tiburon Boulevard	3	2000	6000	2	1000	2000	8000
*Alto Hill	3	1760	5280	2	880	1760	7040
Tamalpais Drive to Lucky Drive	3	2000	6000	1	1000	1000	7000
*Cal Park Hill	3	1860	5580	0			5580
Interstate 580 to 2nd Street	3	2000	6000	1	1000	1000	7000
*Mission Avenue to Lincoln Avenue	4	1640	6560	0			6560
*Puerto Suello Hill	4	1640	6560	1	820	820	7380
North San Pedro Road to Manuel Freitas	3	2000	6000	2	1000	2000	8000
Manuel Freitas to Lucas Valley Road	3	2000	6000	2	1000	2000	8000
Lucas Valley Road to Miller Creek	3	2000	6000	2	1000	2000	8000
*Pacheco Hill	3	1860	5580	2	930	1860	7440
Alameda Del Prado to Ignacio Boulevard	3	2000	6000	1	1000	1000	7000
Ignacio Boulevard to Highway 37	3	2000	6000	1	1000	1000	7000
Highway 37 to Rowland Boulevard	3	2000	6000	0			6000
Rowland Boulevard to DeLong Avenue	3	2000	6000	0			6000
DeLong Avenue to Atherton Avenue	3	2000	6000	0			6000
Atherton Avenue to Sonoma County Line	2	2000	4000	0			4000

Notes: Capacity of the HOV and Auxiliary Lanes Assumed to Equal 50% of the Capacity of a Mixed Flow Lane.
* Capacity at these points adjusted to account for narrow lanes and/or roadway grade. See "Calculation of Highway 101 Adjustment Factors" table.

B. TRANSPORTATION SYSTEM CAPACITY: LOCAL STREETS

The one hour capacity of an arterial street is dependent on the same factors which were described above with regard to the speed of traffic. The capacity of arterials is, therefore, greatly variable among the various kinds of streets found in Marin County. For the purposes of this analysis, arterial lane capacity has been set at average values which result in existing volume-to-capacity ratios and service levels which are consistent with the more detailed Level of Service analysis which has been calculated for street intersections. The hourly capacity for arterials is assumed to be 1,000 vehicles per lane for divided streets and 800 vehicles per lane for undivided streets. In addition, a capacity is established for a category of roadway located in those areas where there are limited intersections and driveways. This type of undivided road is assumed to have a capacity of 1,000 vehicles per lane. The peak one hour, peak direction capacity of several selected arterial segments is shown in Table 9 for 1991 conditions.

On the tables where arterial traffic data is given, two sets of parallel streets are shown as a single arterial because the model is not sufficiently detailed enough to accurately distinguish between closely spaced parallel streets. The two sets of streets which are treated as a single facility are the combination of Sir Francis Drake and Center Boulevards from the San Anselmo "Hub" to Fairfax and Novato Boulevard combined with Center Road from Diablo to Wilson Avenues.

Table 9. Calculation of Arterial Street Capacity, Peak Direction, 1991

Street and Location	Facility Type	Capacity per Lane	# of Lanes	Total Capacity
Bridgeway Boulevard, Spring Street to Nevada Street	Divided Arterial	1000	2	2000
Shoreline Highway, Tennessee Valley Road to Almonte Boulevard	Undivided Arterial	800	2	1600
Almonte Boulevard, Shoreline Highway to Miller Avenue	Undivided Arterial	800	1	800
Miller Avenue, Camino Alto to Montford Avenue	Divided Arterial	1000	2	2000
Blithedale Avenue, Lomita Drive to Camino Alto	Divided Arterial	1000	3	3000
Blithedale Avenue, Elm Avenue to Carmelita Avenue	Undivided Arterial	800	1	800
Tiburon Boulevard, Highway 101 to Frontage Road	Divided Arterial	1000	2	2000
Tiburon Boulevard, Rock Hill Drive to San Rafael Avenue	Undivided Road	1000	1	1000
Paradise Drive, San Clemente Drive to Prince Royal Drive	Divided Arterial	1000	2	2000
Tamalpais Drive, Chapman Drive to Redwood Avenue	Undivided Arterial	800	1	800
Magnolia Avenue, Frances Avenue to Estelle Avenue	Undivided Arterial	800	2	1600
Bon Air Road, South Eliseo Drive to Sir Francis Drake	Undivided Arterial	800	1	800
East Sir Francis Drake, Larkspur Landing Circle to Andersen Drive	Undivided Road	1000	1	1000
Sir Francis Drake, Eliseo Drive to La Cuesta Drive	Divided Arterial	1000	2	2000
Sir Francis Drake, Bon Air Road to Wolfe Grade	Divided Arterial	1000	2	2000
Sir Francis Drake, College Avenue to Laurel Avenue	Divided Arterial	1000	2	2000
Sir Francis Drake/Center Boulevard, West of the "Hub"	Undivided Arterial	800	3	2400
Sir Francis Drake/Center Boulevard, West of Pastori	Undivided Arterial	800	2	1600
Sir Francis Drake, East of Oak Manor Drive	Undivided Arterial	800	1	800
Redhill Avenue, East of the "Hub"	Divided Arterial	1000	2	2000
Point San Pedro Road, West of Marina Way	Divided Arterial	1000	2	2000
North San Pedro Road, East of Civic Center Drive	Undivided Arterial	800	2	1600
Manuel Freitas Parkway, Las Gallinas Avenue to Las Pavadas Avenue	Divided Arterial	1000	2	2000
Lucas Valley Road, Highway 101 to Las Gallinas Avenue	Undivided Road	1000	1	1000
Lucas Valley Road, Miller Creek Road to Mt. Lassen Drive	Undivided Road	1000	1	1000

Table 9 (continued)

Street and Location	Facility Type	Capacity per Lane	# of Lanes	Total Capacity
Bel Marin Keys Boulevard, Nave Drive to Commercial Boulevard	Undivided Arterial	800	2	1600
Ignacio Boulevard, Entrada Drive to San Jose Boulevard	Divided Arterial	1000	2	2000
South Novato Boulevard, Redwood Boulevard to Midway Boulevard	Undivided Arterial	800	1	800
South Novato Boulevard, Rowland Boulevard to Arthur Street	Undivided Arterial	800	1	800
Novato Boulevard/Center Road, Diablo Avenue to Tamalpais Avenue	Undivided Arterial	800	2	1600
Novato Boulevard, San Miguel Way to San Marin Drive	Undivided Arterial	800	1	800
Grant Avenue, 5th to 7th Streets	Undivided Arterial	800	1	800
DeLong Avenue, Sherman Avenue to Redwood Boulevard	Divided Arterial	1000	2	2000
Redwood Boulevard, Delong Avenue to Grant Avenue	Divided Arterial	1000	2	2000
Olive Avenue, Redwood Boulevard to Chase Street	Undivided Arterial	800	1	800
San Marin Drive, Redwood Boulevard to Simmons Lane	Undivided Road	1000	1	1000
Atherton Avenue, Highway 101 to Bugeia Lane	Undivided Road	1000	1	1000
Highway 37, Highway 101 to Atherton Avenue	Freeway	2000	2	4000
Highway 37, Atherton Avenue to County Line	Freeway	2000	2	4000

C. CALIBRATION OF THE TRANSPORTATION MODEL

To ensure that the model was operating properly, several runs of the model were made for dates when actual observed traffic counts could be compared with the results from the model. Model runs were made for 1980, 1987, and 1990. The output from the 1990 model run for Highway 101 segments was compared to the 1987/91 traffic counts as shown in Table 10. The model was generally within the accepted standard for computer models, ±15% from observed data, for most points along Highway 101. Overall, the model appears to be able to simulate traffic flow on Highway 101 within a reasonable level of accuracy.

The model appears to be significantly below observed data at the Sonoma County Line (-35%) and slightly high at Puerto Suello Hill (+17%). Therefore, at the Sonoma County Line and to a lesser extent at Puerto Suello Hill, the estimates from the model needed to be adjusted. Adjustments to model results were made in this analysis using the relationship of the model results to actual counts. It is typical that the output from computer models requires the application of the professional judgments of the transportation planners who use computer models for transportation impact analysis. The two points at which the model differed by more than 15% percent were revised to be within 15% of the counts. The adjustment factor for Puerto Suello Hill is .98; the adjustment factor for the Sonoma County line is 1.31.

Similar comparisons were made for selected arterials. At five arterial segments, the model estimates were more than 15% lower than recent counts. As with freeway screenlines, the model estimates for these segments needed to be adjusted. The arterial segments and there corresponding adjustment factors are:

East Sir Francis Drake, west of Andersen Drive:	1.31
Redhill Avenue, east of the San Anselmo "Hub":	1.15
Bel Marin Keys Boulevard from Nave Drive to Commercial Boulevard:	1.13
DeLong Avenue from Sherman to Redwood:	1.17
Redwood Boulevard from DeLong Avenue to Grant Avenue:	1.39

The model estimates, corresponding counts, and segment capacities for arterials are shown in Table 11.

Table 10. 1990 Transportation Model Results Compared to Traffic Counts, Highway 101
Total Vehicle Trips, Afternoon Peak Hour, Peak Direction

Highway 101 Location	1990 Model Volume	1987/91 Traffic Counts	Model As % of Counts	1991 Capacity	1990 Model V/C	LOS	1987/91 Counts V/C	LOS
*Golden Gate Bridge	6386	6242	102.30%	7120	0.9	D	0.88	D
*Sausalito Lateral to Spencer Avenue	5817			6374	0.91	D	0	N/A
Marin City to State Route 1	6623			9000	0.74	C	0	N/A
Richardson Bay Bridge	6114	6223	98.20%	8000	0.76	C	0.78	D
Seminary Drive to Tiburon Boulevard	5885			8000	0.74	C	0	N/A
*Alto Hill	5696	6506	87.50%	7040	0.81	D	0.92	D
Tamalpais Drive to Lucky Drive	5874	5772	101.80%	7000	0.84	D	0.82	D
*Cal Park Hill	6582	6130	107.40%	5580	1.18	F	1.1	F
Interstate 580 to 2nd Street	7616			7000	1.09	F	0	N/A
*Mission Avenue to Lincoln Avenue	6623			6560	1.01	F	0	N/A
*Puerto Suello Hill	7485	6414	116.70%	7380	1.01	F	0.87	D
North San Pedro Road to Manuel Freitas	7152			8000	0.89	D	0	N/A
Manuel Freitas to Lucas Valley Road	6846			8000	0.86	D	0	N/A
Lucas Valley Road to Miller Creek	6789			8000	0.85	D	0	N/A
*Pacheco Hill	7001	6706	104.40%	7440	0.94	E	0.9	D
Alameda Del Prado to Ignacio Boulevard	6278			7000	0.9	D	0	N/A
Ignacio Boulevard to Highway 37	5996			7000	0.86	D	0	N/A
Highway 37 to Rowland Boulevard	4733	5484	86.30%	6000	0.79	D	0.91	D
Rowland Boulevard to DeLong Avenue	3864			6000	0.64	C	0	N/A
DeLong Avenue to Atherton Avenue	3011			6000	0.5	B	0	N/A
Atherton Avenue to Sonoma County Line	2630	4039	65.10%	4000	0.66	C	1.01	F

* denotes screenlines for Highway 101

Highway 101 "System" Totals:

					V/C	LOS	V/C	LOS
Screenlines	35780	36037	99.30%	38560	0.93	D/E	0.93	D/E

Table 11. 1990 Transportation Model Results Compared to Traffic Counts, Arterials
Total Vehicle Trips, Afternoon Peak Hour, Peak Direction

Street and Location	1990 Model Volume	1987/91 Traffic Counts	Model As%of Counts	1987/91 Traffic Capacity	V/C	LOS
Bridgeway Boulevard, Spring Street to Nevada Street	862	904	95.40%	2000	0.45	A
*Shoreline Highway, Tennessee Valley Road to Almonte Boulevard	1073	1147	93.50%	1600	0.72	C
*Almonte Boulevard, Shoreline Highway to Miller Avenue	552	655	84.30%	800	0.82	D
Miller Avenue, Camino Alto to Montford Avenue	1013	1016	99.70%	2000	0.51	A
Blithedale Avenue, Lomita Drive to Camino Alto	1821	1679	108.50%	3000	0.56	A
Blithedale Avenue, Elm Avenue to Carmelita Avenue	634	656	96.60%	800	0.82	D
*Tiburon Boulevard, Highway 101 to Frontage Road	1802	1665	108.20%	2000	0.83	D
Tiburon Boulevard, Rock Hill Drive to San Rafael Avenue	791	800	98.90%	1000	0.8	C
Summary for Southern Marin	8548	8522	100.30%			
Paradise Drive, San Clemente Drive to Prince Royal Drive	604	684	88.30%	2000	0.34	A
Tamalpais Drive, Chapman Drive to Redwood Avenue	507	510	99.40%	800	0.64	B
Magnolia Avenue, Frances Avenue to Estelle Avenue	627	606	103.50%	1600	0.38	A
Bon Air Road, South Eliseo Drive to Sir Francis Drake	672	650	103.40%	800	0.81	D
*East Sir Francis Drake, Larkspur Landing Circle to Andersen Driv	585	900	65.00%	1000	0.9	D
*Sir Francis Drake, Eliseo Drive to La Cuesta Drive	2075	2088	99.40%	2000	1.04	F
*Sir Francis Drake, Bon Air Road to Wolfe Grade	1583	1840	86.00%	2000	0.92	E
Sir Francis Drake, College Avenue to Laurel Avenue	1264	1150	109.90%	2000	0.58	A
Sir Francis Drake/Center Boulevard, West of the "Hub"	2681	3110	86.20%	2400	1.3	F
Sir Francis Drake/Center Boulevard, West of Pastori	1920	1650	116.40%	1600	1.03	F
Sir Francis Drake, East of Oak Manor Drive	769	880	87.40%	800	1.1	F
Redhill Avenue, East of the "Hub"	1705	2300	74.10%	2000	1.15	F
Point San Pedro Road, West of Marina Way	1020	908	112.30%	2000	0.45	A
*North San Pedro Road, East of Civic Center Drive	637	736	86.50%	1600	0.46	A
Manuel Freitas Parkway, Las Gallinas Avenue to Las Pavadas Avenue	423	479	88.30%	2000	0.24	A
*Lucas Valley Road, Highway 101 to Las Gallinas Avenue	706	626	112.80%	1000	0.63	B
*Lucas Valley Road, Miller Creek Road to Mt. Lassen Drive	487	482	101.00%	1000	0.48	A
Summary for Central Marin	10729	11241	95.40%			

Table 11. (continued)

Street and Location	1990 Model Volume	1987/91 Traffic Counts	Model As%of Counts	1987/91 Traffic Capacity	V/C	LOS
Bel Marin Keys Boulevard, Nave Drive to Commercial Boulevard	1167	1558	74.90%	1600	0.97	E
Ignacio Boulevard, Entrada Drive to San Jose Boulevard	782	627	124.70%	2000	0.31	A
South Novato Boulevard, Redwood Boulevard to Midway Bouelvard	596	521	114.40%	800	0.65	B
South Novato Boulevard, Rowland Boulevard to Arthur Street	1136	1155	98.40%	800	1.44	F
Novato Boulevard/Center Road, Diablo Avenue to Tamalpais Avenue	1783	1497	119.10%	1600	0.94	E
Novato Boulevard, San Miguel Way to San Marin Drive	590	645	91.50%	800	0.81	D
Grant Avenue, 5th to 7th Streets	724	771	93.90%	800	0.96	E
DeLong Avenue, Sherman Avenue to Redwood Boulevard	900	1241	72.50%	2000	0.62	B
Redwood Boulevard, Delong Avenue to Grant Avenue	483	792	61.00%	2000	0.4	A
Olive Avenue, Redwood Boulevard to Chase Street	556	530	104.90%	800	0.66	B
San Marin Drive, Redwood Boulevard to Simmons Lane	723	791	91.40%	1000	0.79	C
*Atherton Avenue, Highway 101 to Bugeia Lane	393	325	120.90%	1000	0.33	A
Summary for North Marin	9833	10453	94.10%			
* denotes Unincorporated Area streets						
Totals for Unincorporated Streets	10452	10954	95.40%			
Highway 37, Highway 101 to Atherton Avenue	1124	2000	56.20%	4000	0.5	A
Highway 37, Atherton Avenue to County Line	1171	1700	68.90%	4000	0.43	A

IX. THE CAUSES OF CONGESTION

During the 1980s, traffic congestion worsened due to a variety of factors, all of which were a natural part of the evolution of the Bay Area economy and Marin's role as a suburban job center in the region. There were also several continuing demographic trends which contributed to increased demand for road space. These changes included:

- a large increase in the number of jobs;
- increased reliance on the automobile as a means of transportation;
- greater geographic dispersion of job sites and housing; and,
- an increase in the number and percentage of people working.

The robust performance of the Bay Area economy during the 1980s created many new businesses and provided enormous employment opportunity. Census Bureau surveys in *County Business Patterns* showed that almost 2,600 new private companies were formed in Marin between 1979 and 1987. Employment estimates from the California Department of Employment Development show an increase of 15,845 jobs, a 20% increase between 1980 and 1987. Because there were only approximately 7,000 new employed residents to fill these jobs, the remaining 9,000 jobs were filled by people commuting into Marin, primarily from Sonoma. This resulted in more traffic congestion than could be accounted for by Marin residents alone. Also, these new businesses generate traffic as customers drive to and from them, as business people visit clients and as deliveries are made between businesses.

The Department of Motor Vehicles reported that there was an increase of 20,363 registered vehicles between December, 1979 and December, 1987. Presumably, many of these vehicles belong to young people with recently acquired drivers' licenses. The rate of vehicle ownership among households in general increased during the 1980s: households purchased their second or third vehicles. A 1987 Planning Department survey showed that the percentage of households owning two cars rose to 45.6% from 38.4% in 1980. The percentage of households owning three or more cars rose to 29.4% from 19.3% in 1980. At the same time, the percentage of one-car households declined from 36.9% to 22.7%.

The 1987 Planning Department report, *Travel Patterns In Marin and Sonoma Counties,* revealed a close relationship between the number of workers in a household and the number of automobiles owned by the household. Households with two workers owned an average of 2.3 automobiles. Beyond that, each additional worker added an automobile to the total average. A reasonable conclusion is that increasing automobile

ownership is due to increasing numbers of workers. A second reasonable conclusion is that almost everyone who works owns a car. Those who work in Marin are almost certain to drive to work.

A combination of factors prompts Marin-based job holders to drive to work. One is economy. Once someone has bought a car, the additional cost of driving to work is relatively small. Given the convenience of driving, this reason alone could explain the popularity of driving. But there are also job-related reasons for driving. A relatively high percentage of Marin jobs are concentrated in retail and service sectors. Many of these jobs do not have standard "9 to 5" hours, the time periods when transit service is best. Part-time and temporary employees comprise 22% of the labor force. They may work non-standard hours and may change jobs more frequently, thereby not settling into a daily pattern that would lend itself to bus riding or carpooling. A 1987 survey prepared for the Marin County Transportation System Management Task Force also found that 56% of employees use their cars for business purposes at least four times a week; 75% use their cars for business at least once a week.

In addition to job-related reasons for driving to work, there are several other important considerations. First, jobs and housing are dispersed throughout the county. People commute to a wide variety of locations, not to a few central locations (as San Francisco-bound commuters do). As job-generating development continues in suburban areas, the trend is towards lower density and continued dispersal of job sites. Rather than tall structures clustered together as in San Francisco, suburban buildings tend to be one or two stories and surrounded by parking. Even in office parks, buildings are spread out. It is not cost-effective to serve this type of development pattern with transit; the automobile provides much better service. The result is that there is much more automobile use in the suburbs than in central cities. While 23% of San Francisco-bound commuters used transit, only 3% of Marin-bound commuters used transit in 1987. Second, there is ample parking at Marin employment sites, unlike in San Francisco. Third, the trips to Marin jobs are short, both in time and distance. Even with congestion on the roads, one can get to work much faster driving than via bus. Carpooling also takes longer than driving alone, due to the time necessary to pick up additional passengers. Because the time involved in Marin commuting is relatively short, an increase in commute time due to carpooling or transit seems like a big increase and on a percentage basis that is true. The time saved by driving alone prompts many people to do so.

The fourth primary reason for increased travel demand was an increase in the number of employed residents. This increase may be attributed to a greater number of young people entering the labor force than older people retiring and an increase in the labor force participation rate, especially among women. (The labor force participation rate is the percentage of people over age fifteen who are working. This rate includes people

over age sixty-five who are still working.) According to a 1990 estimate from the Association of Bay Area Governments, 69.3% of the population over the age of fifteen was working, an increase of 3.0 percentage points from 1980. This increased percentage represents an estimated 15,600 additional employed residents.

Marin's population increased by 3.4% between 1980 and 1990, according to the 1990 Census. This modest population growth *per se* has had a negligible influence on traffic congestion.

X. TRANSPORTATION SYSTEM IMPROVEMENTS

As traffic congestion increased during the 1980s, state and local governments funded and completed a variety of improvements to ease congestion at various locations. Most of the projects were designed to improve traffic flow on local streets and arterials, especially at intersections. Several projects helped increase the capacity of Highway 101, but major work still needs to be done.

Each year the County has submitted a list of proposed transportation system improvements to the Metropolitan Transportation Commission (MTC). MTC reviews the list for compatibility with regional transportational objectives and includes acceptable projects in the Regional Transportation Improvement Program (RTIP). Projects listed in this document receive MTC's endorsement for State and Federal funding.

Another source of funding is the Federal Aid Urban (FAU) program. It is a locally controlled, Federally funded matching program for improving major roads in the urban portion of the county. Each year cities, the County, and the Golden Gate Bridge District propose projects for funding. All of the projects are then competitively ranked based on the significance of the road and the improvement's ability to relieve congestion. The three highest ranking projects are then recommended to city councils and the Board of Supervisors for funding. Federal funds cover 86% of the construction costs. The remaining 14%, engineering costs, and right-of-way acquisition, come from local funds.

The County also receives a small allocation from the Transportation Development Act Article 3 for bikeways and pedestrian paths. Since fiscal year 1980, the County has allocated $606,325 for sixteen bikeway projects and $98,250 for six pedestrian walkways (pedestrians are allowed to use bikeways).

Table T-12 on the following page lists transportation system improvements that were completed or funded during the 1980s. These projects were listed in the Regional Transportation Improvement Program or received FAU funds.

Table 12. Transportation System Improvements Completed and Proposed Projects

PROJECT & LOCATION	DESCRIPTION	COST*	
Completed Projects:			
Highway 101 from Mission St. to Miller Creek Road	High Occupancy Vehicle Lanes	$19.1m	
Tamalpais Drive & Highway 101 interchange	Interchange modifications	$2.4m	
Rowland Blvd. & Highway 101 interchange	Interchange modifications	$3.7m	
Ignacio Blvd. & Highway 101 interchange	Interchange modifications	$2.8m	
Novato Blvd. Between Grant and Wilson	Add left turn lanes at intersections	$1.4m	
College Ave. Between Sir Francis Drake and Murray Lane	Create two-way left turn lane	$573k	
Novato Blvd. Between Wilson and Euclyptus	Lane widening; create left turn lanes	$951k	
Bel Marin Keys Between Arroyo San Jose and Digital Drive	Widen from 2 to 4 lanes	$395k	
Seminary Dr. and 101 interchange	Interchange modifications	$1.5m	
Sir Francis Drake Between College Ave. and Wolfe Grade	Improve traffic signals	$467k	
Sir Francis Drake Between Maple Ave. and Ross town border	Widen road, create left turn lanes	$371k	
Sir Francis Drake at "the Hub" in San Anselmo	Improve traffic signals	$134k	
Tiburon Blvd.	Create left turn lane	$547k	
Los Ranchitos to Lincoln Ave.	Build connector road	$1.7m	
Proposed and Funded Projects:			
Manuel Freitas & 101 interchange	Construct new northbound ramp	$1.4m	Proposed, 1991
Merrydale Road	Construct Overcrossing	$4.1m	Proposed, 1991
Waldo Interchange	Interchange modifications	$3.0m	Proposed, 1993
Highway 101 Between Sir Francis Drake and Bellam Blvd.	Construct northbound auxiliary lane	$6.3m	Proposed, 1993
Highway 101 Between Mission St. and North San Pedro Rd.	Construct HOV lane and auxiliary lane	$29.1m	Proposed, 1993
Highway 101 Between North San Pedro and Miller Creek Rd.	Construct auxiliary lanes	$6.7m	Proposed, 1993
Highway 101 Between Central San Rafael and I 580	Construct HOV and auxiliary lanes	$38.5m	Proposed, 1993
Andersen Drive in San Rafael	Extend to Irwin St.	$14.1m	Proposed, 1993

* NOTE: In the COST column "m" stands for millions of dollars; "k" stands for thousands of dollars.

APPENDIX 1. REFERENCES

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